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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/746,064	12/26/2000	Mizuhisa Nihei	001701	1990

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EXAMINER

BAUMEISTER, BRADLEY W

ART UNIT PAPER NUMBER

2815

DATE MAILED: 02/09/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

09/746,064

Applicant(s)

NIHEI ET AL.

Examiner

B. William Baumeister

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE \_\_\_\_ MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☐ Responsive to communication(s) filed on 03 December 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 3-8, 10-13 and 15 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 3-8, 10-13 and 15 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |   |  |
|---|--|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. ____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                  | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)            |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date ____ | 6) <input type="checkbox"/> Other: ____  |

**DETAILED ACTION**

***Claim Rejections - 35 U.S.C. § 103***

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.
2. Claims 3, 4, 10-13 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants Admitted Prior Art in view of Imaizumi et al. '717.
  - a. Applicant acknowledges that it was known to make metal gate MESFETs and HEMTs with S/D and G contacts that are composed of Ti/Pt/Au. These prior-art HEMTs include an electron supply layer 13. (See e.g., prior art FIG 1 and the BACKGROUND OF THE INVENTION portion of the specification.) Applicant does not disclose that it was known to further provide metal oxides interposed between the metal gate and the channel.
  - b. Imaizumi discloses MESFETs having Schottky gate electrodes formed over III-V semiconductor layers with a thin metal oxide interposed therebetween. The oxides may be formed of various metals such as Ti, Co or Ni. Further, while Imaizumi provides express examples of InP based semiconductors, the teachings are not so limited. Rather, the reference expressly states that the invention may be employed in other III-V semiconductor systems (col. 6, lines 1-3). It would have been obvious to one of ordinary skill in the art at the time of the invention to have employed a metal oxide as taught by Imaizumi at the metal gate/semiconductor interface of the prior-art MESFET or HEMT for the purpose of reducing the leakage current and increasing the breakdown voltage as taught by Imaizumi (e.g., ABSTRACT).

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c. Regarding claims 3 and 4, regardless of whether Imaizumi expressly recites whether the oxide is stoichiometric or not, it was well known to those of ordinary skill in the art at the time of the invention that whether the oxide's composition is stoichiometric depends on the oxidation times and conditions, and no unexpected results would result from using one vs the other.

d. Previously added claim 14 sets forth that the intermediate ( $\text{TiO}_2$ ) layer has a thickness of about 4 nm (or about 40 angstroms). Newly added claim 15 more narrowly recites a thickness of 4 nm (not "about 4 nm.") Imaizumi further discloses that the oxide thickness must be limited to less than 10 monolayers (e.g., col. 2, line 15 and line 56; and col. 4, line 7 and line 37). Note Teraguchi '514 which provides evidence of the fact that the lattice constant of  $\text{TiO}_2$  is 4.593 angstroms (see col. 5, Table 3). As such, Imaizumi's disclosure of an oxide thickness that is less than 10 monolayers can be restated as saying that the oxide thickness must be less than about 4.593 nm, which reads on the thickness set forth in claims 14 and 15. It would have been obvious to one of ordinary skill in the art at the time of the invention to have formed the oxide to a thickness that is less than 4.6 nm—which is "about 4 nm" per claim 14, and which includes "4 nm" per claim 15—for the purpose of preventing the formation of dangling bonds, and thereby allow a Schottky electrode with a sufficiently high barrier height to be obtained, as taught by Imaizumi (e.g., col. 2, lines 40-).

3. Claims 5-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art--Imaizumi et al. '717 as applied to the claims above and further in view of Kirchner et al. '450 (previously made of record). Imaizumi teaches that the oxide may be interposed between the gate and the semiconductor, but does not further teach that it may be

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employed over other regions of the surface.

a. Kirchner discloses FETs having a tunneling oxide insulating layer interposed between the gate and channel. Further, various embodiments depict that the oxide may be formed under the S/D regions (FIG 9) and may cover the entire surface (FIG 10). It would have been obvious to one of ordinary skill in the art at the time of the invention to have further employed the tunnel metal oxide as taught by Applicant's Admitted Prior Art--Imaizumi under the S/D regions as taught by Kirchner for the purpose of preventing metal from diffusing therefrom into the semiconductor. It would have been further obvious to coat the entire surface for the purpose of simplifying the masking design.

#### ***Response to Arguments***

4. Applicant's arguments filed 12/3/2003 have been fully considered but are not persuasive.

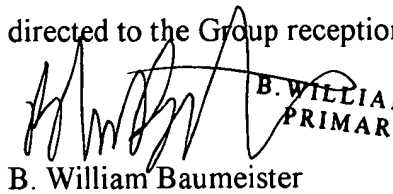
a. Applicant has argued that Imaizumi does not disclose an electron supplying layer. This argument is not persuasive because, as was explained above, Applicant's prior-art does teach that electron supplying layers may be further provided above the channel.

b. Applicant re-asserts his previous argument filed 10/6/2003 (paper #17) that the claimed thickness of 4 nm is twice as large as that disclosed by Imaizumi because 10 monolayer of TiO<sub>2</sub> equates to a thickness of 2.297 Angstroms. This argument is not persuasive because Applicant's calculations are based on the faulty premise of equating the TiO<sub>2</sub>'s lattice constant dimension with its unit-cell dimension. In fact, these characteristics are different and have completely different lengths. Thus, Applicant's resultant calculations are incorrect.

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***Contact Information***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister**, at **(571) 272-1722**. The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Tom Thomas, can be reached at (571) 272-1664. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

  
**B. WILLIAM BAUMEISTER**  
**PRIMARY EXAMINER**  
B. William Baumeister

Primary Examiner, Art Unit 2815

February 4, 2004